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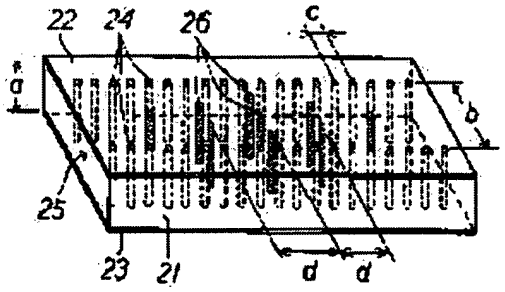
(54) WAVEGUIDE-TYPE BAND PASS FILTER

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a waveguide-type band pass filter whose productivity is high and which can correspond to miniaturization.

SOLUTION: A waveguide-type band pass filter is provided with a pair of main conductor layers 22 and 23, holding a dielectric substrate 21 and the sidewall through conductor groups 24 of two lines, which are formed by electrically connecting the main conductor layers 22 and 23 at the intervals of loss than half of a signal wavelength in a signal transmitting direction. A plurality of through conductors 26 for electrically connecting the main conductor layers 22 and 23 and forming introduction widows are arranged in a dielectric conductor line 25. Which transmits a high frequency signal by an area surrounded by the main conductor layers 22 and 23 and the sidewall through conductor groups 24 at the intervals of not more than the half of the wavelength in a pipe in the signal transmitting direction. Thus, the miniature waveguide-type band pass filter, whose productivity is high and which has a satisfactory characteristic, is provided.



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* NOTICES *

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CLAIMS

[Claim(s)]
[Claim 1] Provide a group and it changes. the penetration for side attachment walls of two trains which connected between the aforementioned initiative body whorls in the initiative body whorl and the direction of a signal transmission of the couple which pinches a dielectric substrate electrically less than [of signal wave length] at intervals of 1/2, and were formed in them -- a conductor -- the aforementioned initiative body whorl and the penetration for side attachment walls -- a conductor -- inside the dielectric-waveguide track which transmits a RF signal by the field surrounded by the group two or more penetration which connects between the aforementioned initiative body whorls electrically, and forms an inductive window -- the waveguide type band-pass filter characterized by arranging the conductor in the aforementioned signal-transmission direction less than [of the guide wave length] at intervals of 1/2
[Claim 2] between the aforementioned initiative body whorls -- the aforementioned penetration for side attachment walls -- a conductor -- the waveguide type band-pass filter according to claim 1 characterized by forming in the aforementioned initiative body whorl and parallel the subconductor layer electrically connected with the group
[Claim 3] the aforementioned subconductor layer installs in the interior of the aforementioned dielectric-waveguide track -- having -- the aforementioned penetration -- it connects with a conductor electrically -- having -- this penetration -- the waveguide type band-pass filter according to claim 2 characterized by forming the aforementioned inductive window with the conductor

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] this invention relates to the waveguide type band-pass filter using the dielectric-waveguide track which mainly transmits RF signals, such as microwave and a millimeter wave.
[0002]
[Description of the Prior Art] In recent years, research of the mobile communications using RFs, such as microwave and a millimeter wave, the radar between vehicles, etc. is advanced briskly. The band-pass filter which lets only the RF signal of specific frequency pass is required for the technology using these RFs.
[0003] Although there is a thing of various composition in the band-pass filter for RFs, the waveguide type band-pass filter using the rectangular waveguide as what has a good band-pass property is known. There is a thing of structure as shown in drawing 6 and drawing 7 with an outline perspective diagram in this.
[0004] The thing of the structure shown in drawing 6 forms a band-pass filter by arranging perpendicularly the short pins 2 (2a-2e), such as two or more metal rods which form an inductive window in the interior of a rectangular waveguide 1, in the direction of a signal transmission less than [of guide wave length lambdag] at intervals of [d] 1/2 (d<lambdag/2).
[0005] According to this structure, the width of face of a waveguide is divided by short pin 2c or the short pin groups 2a-2e of a waveguide which are in a center section mostly 1/2 or less [of a cutoff wave length]. Consequently, the electromagnetic wave which has spread the waveguide by the short pin 2 is field L1 -L4 shown all over this drawing since it was reflected. It can be regarded as the space closed electrically. This closed space has a peculiar resonance mode, and when the length d is lambdag/2, it functions as a resonator which causes resonance on low frequency most. In the case of the structure shown in drawing 6 , it can be regarded as what four resonators formed with the wall by the short pin 2 have combined with the waveguide in series.
[0006] the case where it is in agreement with the peculiar resonance frequency which the resonator which the frequency of the electromagnetic wave mentioned above has although it becomes impossible to have spread the electromagnetic wave which has spread the waveguide 1 from the input side of the left in drawing 6 by short pin 2a as mentioned above -- the electromagnetism from between short pin 2a (inductive window) -- combination of-like -- resonance field L1 Energy flows. the same -- carrying out -- L1 from -- L2 L2 from -- L3 L3 from -- L4 Energy spreads and it spreads as an electromagnetic wave again from the output side of the method of the right in drawing 6 of a waveguide 1. Therefore, only an electromagnetic wave with peculiar frequency can pass through the field by such structures, and, thereby, operates as a band-pass filter.
[0007] In addition, resonance field L1 -L4 mentioned above Since there is an inductive window for combination, generally those length d becomes shorter than lambdag/2.
[0008] Moreover, the thing of the structure shown in drawing 7 forms a band-pass filter by similarly

arranging perpendicularly the short boards 3, such as two or more metal plates which form an inductive window (inductive wall) in the interior of a rectangular waveguide 1, in the direction of a signal transmission less than [of guide wave length lambdag] at intervals of [d] 1/2 (d<lambdag/2).
[0009] According to this, it becomes a band-pass filter by working completely like the short board 3, the short pin 2 which the inductive window by it mentioned above, and its crevice.
[0010]
[Problem(s) to be Solved by the Invention] The band-pass property over a RF signal had the trouble that processing at the time of production was difficult, although the band-pass filter by the conventional rectangular waveguide with such structure was excellent. For this reason, there was a trouble that cost became [productivity] low highly as a result.
[0011] Moreover, since the size of the rectangular waveguide itself was large, the band-pass filter using this also became big, and the trouble of being difficult also had the miniaturization for using for mobile communications, the radar between vehicles, etc.
[0012] It is [0013] which this invention is thought out in view of the above-mentioned situation, and is for the purpose to offer the waveguide type band-pass filter with which productivity can respond also to a miniaturization highly.
[Means for Solving the Problem] This invention persons replace with the conventional rectangular waveguide, as a result of repeating examination to the above-mentioned trouble. As [show / an outline perspective diagram /, respectively / to drawing 4 and drawing 5] the penetration for side attachment walls of two trains which connected between initiative body whorls electrically less than [of signal wave length] at intervals of 1/2, and were formed in the direction of a signal transmission into the dielectric substrate pinched by the initiative body whorl of a couple -- a conductor -- by the group The dielectric-waveguide track (see Japanese Patent Application No. No. 229925 [eight to] in a JP,6-53711,A row) in which the side attachment wall of a waveguide was formed is used. two or more penetration equivalent to the short pin which forms an inductive window in the interior of the dielectric-waveguide track -- by forming a conductor and arranging in the direction of a signal transmission less than [of the guide wave length] at intervals of 1/2 It found out that the same waveguide type band-pass filter as the structure shown in the drawing 6 row at drawing 7 using the dielectric-waveguide track could be manufactured.
[0014] The initiative body whorl of the couple to which the waveguide type band-pass filter of this invention pinches a dielectric substrate, Provide a group and it changes. the penetration for side attachment walls of two trains which connected between the aforementioned initiative body whorls in the direction of a signal transmission electrically less than [of signal wave length] at intervals of 1/2, and were formed in it -- a conductor -- the aforementioned initiative body whorl and the penetration for side attachment walls -- a conductor -- inside the dielectric-waveguide track which transmits a RF signal by the field surrounded by the group two or more penetration which connects between the aforementioned initiative body whorls electrically, and forms an inductive window -- it is characterized by arranging the conductor in the aforementioned signal-transmission direction less than [of the guide wave length] at intervals of 1/2
[0015] moreover, the waveguide type band-pass filter of this invention -- the above-mentioned composition -- setting -- between the aforementioned initiative body whorls -- the aforementioned penetration for side attachment walls -- a conductor -- it is characterized by forming in the aforementioned initiative body whorl and parallel the subconductor layer electrically connected with the group
[0016] furthermore, in the waveguide type band-pass filter of the above-mentioned composition with which the subconductor layer was formed, the aforementioned subconductor layer installs the waveguide type band-pass filter of this invention in the interior of the aforementioned dielectric-waveguide track -- having -- the aforementioned penetration -- it connects with a conductor electrically -- having -- this penetration -- it is characterized by forming the aforementioned inductive window with the conductor
[0017]

[Embodiments of the Invention] Hereafter, it explains, referring to a drawing about the waveguide type band-pass filter of this invention.
[0018] Drawing 4 and drawing 5 are the outline perspective diagrams showing the composition of the dielectric-waveguide track used for the waveguide type band-pass filter of this invention, respectively. the penetration for side attachment walls of the initiative body whorl of the couple to which 11 pinches a dielectric substrate and 12-13 pinches the dielectric substrate 11 in these drawings, and two trains which 14 connected between the initiative body whorls 12.13 in the direction of a signal transmission electrically less than [of signal wave length] at intervals of 1/2, and were formed -- a conductor -- it is a group
[0019] According to drawing 4 and drawing 5 , the initiative body whorl 12-13 of a couple is formed in the position which pinches the dielectric substrate 11 of predetermined thickness a, and the initiative body whorl 12-13 is formed in the vertical side of the dielectric substrate 11 which faces across a waveguide track formation position at least. moreover, the through hole which connects the initiative body whorls 12 and 13 electrically between the initiative body whorls 12.13 -- a conductor and a beer hall -- penetration of a conductor etc. -- many conductors prepare -- having -- the penetration for side attachment walls of two trains -- a conductor -- the group 14 is formed
[0020] the penetration for side attachment walls of two trains -- a conductor -- a group 14 has the predetermined interval (width of face) b, is formed in the direction of a signal transmission with less than 1/2 predetermined interval c of signal wave length, and, thereby, forms the side attachment wall in this dielectric-waveguide track
[0021] Although there is especially no limit to the interval between thickness [of the dielectric substrate 11] a12.13, i.e., the initiative body whorl of a couple, here It is good to consider as about 1/2 and a double-precision grade to an interval b, in using by the single mode. the portion which is equivalent to the H plane of a dielectric waveguide, and the Eth page in the example of drawing 4 and drawing 5 -- respectively -- the initiative body whorl 12-13 and the penetration for side attachment walls -- a conductor -- it forms by the group 14 -- having -- an interval b -- receiving -- thickness a -- a double-precision grade -- then the portion which is equivalent to the Eth page and H plane of a dielectric waveguide -- respectively -- the initiative body whorl 12-13 and the penetration for side attachment walls -- a conductor -- it will be formed by the group 14 moreover, the thing for which an interval c is set as less than 1/2 interval of signal wave length (cutoff wave length) -- the penetration for side attachment walls -- a conductor -- the group 14 forms the electric wall
[0022] since a TEM wave can be spread between the initiative body whorls 12.13 of the couple arranged in parallel -- the penetration for side attachment walls -- a conductor -- if the interval c of a group 14 is larger than signal wave length, i.e., cutoff wave length, lambdac, even if it supplies electric power to this waveguide track in an electromagnetic wave, it will not spread along with the false waveguide made here however, the penetration for side attachment walls -- a conductor -- if the interval c of a group 14 is smaller than cutoff-wave-length lambdac, an electromagnetic wave cannot be perpendicularly spread to a waveguide track, but it will be spread in the direction of a signal transmission of a waveguide track, reflecting consequently -- according to the composition of drawing 4 and drawing 5 -- the penetration for side attachment walls of the initiative body whorl 12-13 of a couple, and two trains -- a conductor -- the field of the size of axb serves as [the cross section surrounded by the group 14] the dielectric-waveguide track 15
[0023] 16 [in addition,] in drawing 5 -- the penetration for side attachment walls -- a conductor -- the penetration which forms each train of a group 14 -- a conductor -- it is the subconductor layer which connects comrades electrically and which was formed in parallel with the initiative body whorl 12-13, and is suitably formed of a request if it sees from the interior of the dielectric-waveguide track 15 by forming such a subconductor layer 16 -- the side attachment wall of a track -- the penetration for side attachment walls -- a conductor -- by the group 14 and the subconductor layer 16, it becomes the shape of a fine grid and the shielding effect of the electromagnetic wave from a track can be heightened further

[0024] moreover -- these modes -- the penetration for side attachment walls -- a conductor -- although

the group 14 was formed in two trains -- this penetration for side attachment walls -- a conductor -- a group 14 -- four trains or six trains -- arranging -- the penetration for side attachment walls -- a conductor -- the false conductor by the group 14 -- forming a wall in three-fold [a duplex and] -- a conductor -- the leakage of the electromagnetic wave from a wall can be prevented more effectively
[0025] According to the above-mentioned dielectric-waveguide track, since it becomes the transmission line by the dielectric waveguide, the waveguide size will become the size of 1/rootepsilon of the usual waveguide, if specific inductive capacity of the dielectric substrate 11 is set to epsilon. Therefore, waveguide size can be made small and becomes the size which can be used as the transmission line of the multilayer-interconnection substrate or the package for semiconductor device receipt in which wiring is formed with high density, or the radar between vehicles, so that material with large specific inductive capacity epsilon constitutes the dielectric substrate 11.
[0026] in addition, the penetration for side attachment walls -- a conductor -- the penetration which constitutes a group 14 -- the conductor is arranged as mentioned above less than [of cutoff-wave-length lambdac] at intervals of [c] 1/2, and although considering as a fixed repeat interval is desirable as for this interval c in order to realize a good transmission characteristic, if it is less than 1/2 interval of cutoff-wave-length lambdac, it cannot be overemphasized that it may be made to change suitably or some values may be combined
[0027] Although it does not divide and limit if it has the property which functions as a dielectric and does not bar transmission of a RF signal as a dielectric substrate 11 which constitutes such a dielectric-waveguide track, the dielectric substrate 11 from the point of the precision at the time of forming the transmission line and the ease of manufacture has ceramics to a desirable bird clapper.
[0028] Although ceramics with specific inductive capacity various until now as such ceramics are known, in order to transmit a RF signal on the waveguide track of this invention, it is desirable that they are paraelectrics. Generally this is because as for ferroelectric ceramics dielectric loss becomes large in a RF field and transmission loss becomes large. Therefore, specific-inductive-capacity epsilonr of the dielectric substrate 11 4-100 A grade is suitable.
[0029] Moreover, for the line breadth of the wiring layer generally formed in a multilayer-interconnection substrate, or the package for semiconductor device receipt or the radar between vehicles, specific inductive capacity since it is about 1mm at the maximum is 100. When it uses so that the upper part may become the electromagnetic-field distribution which an H plane, i.e., a magnetic field, rolls in parallel with an upper field using material, the minimum frequency which can be used is computed with 15GHz, and use of it is attained also in the field of a microwave band. The dielectric which consists of a resin generally used as a dielectric substrate 11 on the other hand is specific-inductive-capacity epsilonr. Since it is about two, when line breadth is 1mm, it cannot use, unless it is more than about 100 GHz.
[0030] Moreover, although there is much what has a very small dielectric dissipation factor in such paraelectrics ceramics like an alumina or a silica, all paraelectrics ceramics cannot be used. In the case of a dielectric-waveguide track, the loss by the conductor is not almost, most losses at the time of a signal transmission are losses by the dielectric, and the loss alpha by the dielectric (dB/m) is expressed as follows.
alpha=27.3xtandelta/[lambda/{1-(lambda/lambdac) 2} 1 / 2]
Inside of a formula, tandelta: Dielectric dissipation factor lambda of a dielectric : Wavelength lambdac in a dielectric : When it applies to the rectangular-waveguide (WRJ series) configuration by which cutoff-wave-length standardization was carried out, it is {1-(lambda/lambdac) 2} 1/2 in an upper formula. It is about 0.75.
[0031] Therefore, in order to carry out to below -100 dB/m that is the transmission loss with which practical use can be presented, it is required to choose a dielectric so that the following relation may be materialized.
[0032] f is frequency (GHz) to be used among fxepsilon r 1 / 2 xtandelta<=0.8 formula.
[0033] As such a dielectric substrate 11, there are alumina ceramics, a crystallized glass, alumimium nitride ceramics, etc., for example. The ceramic green sheet of two or more sheets is obtained by adopting a well-known doctor blade method, the well-known calendering-roll method, etc.

conventionally, and making this with the shape of a sheet, while carrying out addition mixture of the suitable organic solvent and solvent for ceramic raw material powder and making it slurry-like. For example, after an appropriate time, While giving suitable punching processing for each of these ceramic green sheet, the laminating of these is carried out. In the case of alumina ceramics, in the case of 1500-1700 degrees C and a crystallized glass, it is manufactured by calcinating at the temperature of 1600-1900 degrees C in the case of 850-1000 degrees C and alumimium nitride ceramics.

[0034] Moreover, when the dielectric substrate 11 consists of alumina ceramics as an initiative body whorl 12-13 of a couple, for example, By the thick-film-screen-printing method, at least, what carried out addition mixture of oxides, the organic solvent, solvents, etc., such as a suitable alumina silica magnesia for metal powders, such as a tungsten, and was made into the shape of a paste is printed on a ceramic green sheet so that the transmission line may be covered completely. After an appropriate time, It calcinates at the elevated temperature of about 1600 degrees C, and as it becomes the thickness of 10-15 micrometers or more, it forms. In addition, in the case of a crystallized glass, in the case of alumimium nitride ceramics, as a metal powder, tungsten molybdenum is suitable for copper, gold, and silver. Moreover, generally thickness of the initiative body whorl 12-13 is set to about 5-50 micrometers.

[0035] moreover, the penetration for side attachment walls -- a conductor -- the penetration which constitutes a group 14 -- as a conductor -- a beer hall -- a conductor and a through hole -- the cross-section configuration is [that what is necessary is just to form by the conductor etc.] also easy to manufacture -- it is circular and also you may be polygons, such as a rectangle and a rhombus these penetration -- the metal paste same to the breakthrough which pierced the conductor for example, to the ceramic green sheet, processed, and was produced as the initiative body whorl 12-13 -- embedding -- the after an appropriate time and dielectric substrate 11 -- simultaneously, it calcinates and forms in addition, these penetration -- a conductor -- diameters 50-300 mum is suitable.

[0036] Next, an example of the gestalt of operation of the waveguide type band-pass filter of this invention using such a dielectric-waveguide track is explained based on drawing 1 and drawing 2 .

[0037] Drawing 1 is the outline perspective diagram showing an example of the gestalt of operation of the waveguide type band-pass filter of this invention, and drawing 2 is a plan. The initiative body whorl of the couple which 21 pinched the dielectric substrate of thickness a, and 22 and 23 pinched the dielectric substrate 21, and was formed in these drawings, the penetration for side attachment walls of two trains which had 24 at intervals of [b] predetermined (width of face), connected between the initiative body whorls 22.23 in the direction of a signal transmission electrically less than [of signal wave length (cutoff-wave-length lambdac)] at intervals of [c] 1/2, and were formed in it -- a conductor -- a group -- 25 -- the penetration for side attachment walls of the initiative body whorl 22-23 of a couple, and two trains -- a conductor -- it is the dielectric-waveguide track section constituted by the field surrounded by the group 24

[0038] these dielectrics substrate 21, the initiative body whorl 22-23, and the penetration for side attachment walls -- a conductor -- a group 24 is constituted like the dielectric-waveguide track used for the above-mentioned this invention

[0039] moreover, two or more penetration which 26 which gave and showed the slash all over these drawings connects electrically between the initiative body whorls 22.23 arranged in the interior of the dielectric-waveguide track 25 in the direction of a signal transmission less than [of guide wave length lambdag] at intervals of [d] 1/2 (d<lambdag/2), and forms an inductive window -- it is a conductor

[0040] two or more penetration which forms an inductive window in the interior of the dielectric-waveguide track 25 in this way according to this invention -- a conductor 26 -- less than 1/2 predetermined interval d of guide wave length lambdag -- having -- arranging -- these penetration -- by adjusting the number of conductors 26 The dielectric-waveguide track 25 constituted by the group 24 is equivalent to the rectangular waveguide 1 shown in drawing 6 . the penetration for side attachment walls of the initiative body whorl 22-23 of a couple, and two trains -- a conductor -- two or more penetration -- a conductor 26 becomes a thing equivalent to the short pin 2 shown in drawing 6 , and the same waveguide type band-pass filter can be formed by the completely same principle as the waveguide type

band-pass filter using the rectangular waveguide shown in drawing 6
[0041] According to the waveguide type band-pass filter of such this invention, since it becomes a dielectric waveguide and can produce small compared with the waveguide type band-pass filter using the conventional rectangular waveguide, it can make in the dielectric substrate which constitutes a multilayer-interconnection substrate and the package for semiconductor device receipt, and the correspondence to a miniaturization serves as an easy waveguide type band-pass filter. And since it is easily producible with sheet laminating technology, such as a green-sheet laminated layers method, it becomes the waveguide type band-pass filter in which manufacture with it is possible. [high productivity and] [cheap]
[0042] two or more penetration which forms an inductive window in the waveguide type band-pass filter of this invention -- the penetration which functions as a short pin when arranging a conductor 26 -- each interval, a number, a size, etc. of a conductor 26 participate in a filter shape intricately For this reason, the waveguide type band-pass filter which has a desired band-pass property will be obtained by calculating repeatedly in electromagnetic-field analysis so that the filter shape demanded may be satisfied.
[0043] moreover, two or more penetration which forms an inductive window to the dielectric-waveguide track which showed the waveguide type band-pass filter shown in drawing 1 and drawing 2 to drawing 4 -- the dielectric-waveguide track further shown in this at drawing 5 although it had become the composition which arranged the conductor 26 -- like -- between the initiative body whorls 22.23 -- the initiative body whorl 22-23 -- parallel -- the penetration for side attachment walls -- a conductor -- you may form the subconductor layer electrically connected with the group 24 the case where a subconductor layer is formed such -- the penetration for side attachment walls -- a conductor -- the false conductor formed of a group 24 -- since a wall is strengthened as an electric wall, the transmission characteristic and shielding effect of an electromagnetic wave can be heightened further, and it becomes the waveguide type band-pass filter which has a good band-pass property
[0044] Next, the same plan as drawing 2 shows other examples of the gestalt of operation of the waveguide type band-pass filter of this invention to drawing 3 . Drawing 3 is the plan showing the internal structure of the waveguide type band-pass filter of this invention as well as drawing 2 , and has given the same sign to the same part as drawing 2 in drawing 3 .
[0045] Drawing 3 realizes composition of the conventional waveguide type band-pass filter shown in drawing 7 using the dielectric-waveguide track concerning this invention which has the subconductor layer 16 shown in drawing 5 as a dielectric-waveguide track. two or more penetration which 27 connects electrically between the initiative body whorls 22.23 arranged in the interior of the dielectric-waveguide track 25 in the direction of a signal transmission less than [of guide wave length lambdac] at intervals of [d] 1/2 in drawing 3 , and forms an inductive window -- a conductor -- it is -- penetration of these plurality -- as a conductor 27 forms the same inductive window as the short board 3 shown in drawing 7 , it is arranged in the waveguide
[0046] 28 is a subconductor layer and moreover, the subconductor layer 28 in this example the penetration for side attachment walls of two trains -- a conductor, while connecting with the group 24 electrically in each train It connects with a group 24 side electrically. the penetration for side attachment walls of the initiative body whorl 22-23 of a couple, and two trains -- a conductor -- two or more penetration which is installed in the interior of the dielectric-waveguide track 25 formed of the field surrounded by the group 24, and forms an inductive window -- a conductor 27 and each penetration for side attachment walls -- a conductor -- this installed portion -- penetration -- the inductive window is formed with the conductor 27
[0047] thus, two or more penetration -- it installs in a conductor 27 and the interior of the dielectric-waveguide track 25 -- having -- these penetration -- by arranging the inductive window formed by the subconductor layer 28 electrically connected with the conductor 27 at the less than [of guide wave length lambdag] 1/2 predetermined intervals d The dielectric-waveguide track 25 constituted by the group 24 is equivalent to the rectangular waveguide 1 shown in drawing 7 . the penetration for side attachment walls of the initiative body whorl 22-23 of a couple, and two trains -- a conductor -- two or

more penetration -- the inductive window formed of a conductor 27 and the subconductor layer 28 becoming a thing equivalent to the short board 3 shown in drawing 7 , and by the completely same principle as the waveguide type band-pass filter shown in drawing 6 and drawing 7 The waveguide type band-pass filter using the rectangular waveguide shown in drawing 7 and the same waveguide type band-pass filter can be formed.
[0048] Also with such a waveguide type band-pass filter of this invention, the correspondence to a miniaturization is easy and serves as a waveguide type band-pass filter in which manufacture with it is possible. [high productivity and] [cheap]
[0049] two or more penetration which forms an inductive window like this example -- the penetration mentioned above when a conductor 27 and the subconductor layer 28 were arranged -- the waveguide type band-pass filter which has a desired band-pass property will be obtained using an analysis simulator so that the filter specification demanded may be satisfied like the case of a conductor 26
[0050] in addition, two or more penetration -- a conductor 26-27 -- the penetration for side attachment walls -- a conductor -- penetration of a group 24 -- what is necessary is just to form as mentioned above like a conductor Moreover, the cross-section configuration is not restricted circularly, but is good according to a desired band-pass property also as an ellipse form, a triangle, a square and a polygon, or plate-like.
[0051] In addition, this invention is not limited to the example of the gestalt of the above operation, and giving change and improvement various in the range which does not deviate from the summary of this invention does not interfere at all. For example, although the resonance section considered as four steps (L1 -L4) of filters in the above example, according to the specification of a filter, it is good also as a multi-stage filter.
[0052]
[Effect of the Invention] According to the waveguide type band-pass filter of this invention, as explained in full detail above inside a dielectric-waveguide track two or more penetration which connects electrically between the initiative body whorls of the couple which pinches a dielectric substrate, and forms an inductive window -- a conductor from having arranged in the direction of a signal transmission less than [of guide wave length lambdag] at intervals of 1/2 Since it becomes a dielectric waveguide and can produce small compared with the waveguide type band-pass filter using the conventional rectangular waveguide, it can make in dielectric substrates, such as a multilayer-interconnection substrate. Since the correspondence to a miniaturization serves as an easy waveguide type band-pass filter and it can moreover produce easily with sheet laminating technology, such as a green-sheet laminated layers method, it becomes the waveguide type band-pass filter in which manufacture with it is possible. [high productivity and] [cheap]
[0053] moreover -- according to the waveguide type band-pass filter of this invention -- between initiative body whorls -- the penetration for side attachment walls -- a conductor -- the case where the subconductor layer electrically connected with the group is formed in an initiative body whorl and parallel -- the penetration for side attachment walls -- a conductor -- the false conductor formed of a group -- since a wall is strengthened as an electric wall, the transmission characteristic and shielding effect of an electromagnetic wave can be heightened further, and it becomes the waveguide type band-pass filter which has a good band-pass property
[0054] furthermore, the penetration which according to the waveguide type band-pass filter of this invention installs a subconductor layer in the interior of a dielectric-waveguide track, and forms an inductive window -- a conductor -- electric -- connecting -- penetration -- since the portion of the conductor which forms an inductive window increases when an inductive window is formed with a conductor, concentration of the current to a conductor is eased and loss of the energy by the conductor has the more excellent property from a bird clapper small
[0055] According to this invention, by the above, productivity was able to offer the waveguide type band-pass filter which can respond also to a miniaturization highly as a waveguide type band-pass filter using the dielectric-waveguide track.

[Translation done.]

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the perspective diagram showing an example of the gestalt of operation of the waveguide type band-pass filter of this invention.
[Drawing 2] It is the plan showing an example of the gestalt of operation of the waveguide type band-pass filter of this invention.
[Drawing 3] It is the plan showing other examples of the gestalt of operation of the waveguide type band-pass filter of this invention.
[Drawing 4] It is a perspective diagram for explaining the dielectric-waveguide track concerning the waveguide type band-pass filter of this invention.
[Drawing 5] It is a perspective diagram for explaining the dielectric-waveguide track concerning the waveguide type band-pass filter of this invention.
[Drawing 6] It is the perspective diagram showing the example of the conventional waveguide type band-pass filter.
[Drawing 7] It is the perspective diagram showing other examples of the conventional waveguide type band-pass filter.
[Description of Notations]
11 21 ..... Dielectric substrate
12, 13, 22, 23 .... Initiative body whorl
14 and 24 ..... the penetration for side attachment walls -- a conductor -- a group
15 25 ..... Dielectric-waveguide track
26 and 27 ..... penetration -- a conductor
16 28 ..... Subconductor layer

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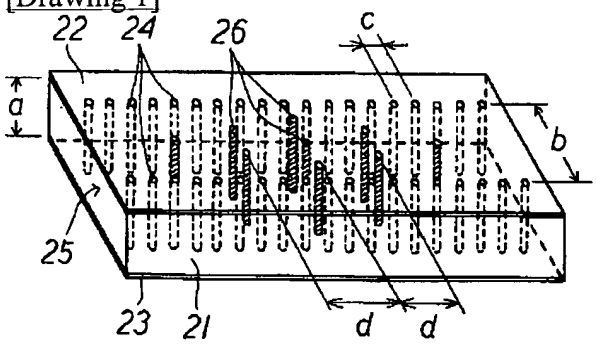
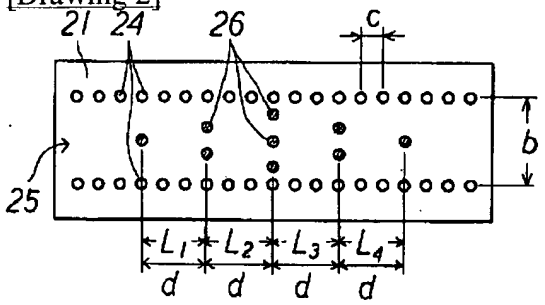
DRAWINGS

[Drawing 1]



[Drawing 2]



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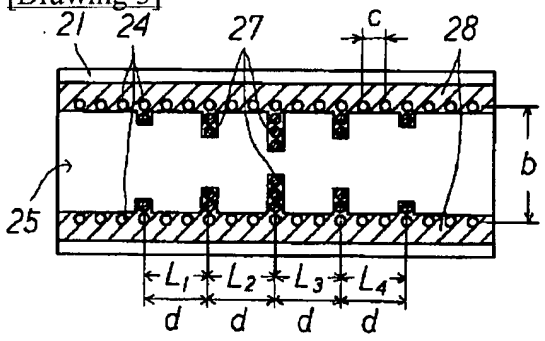

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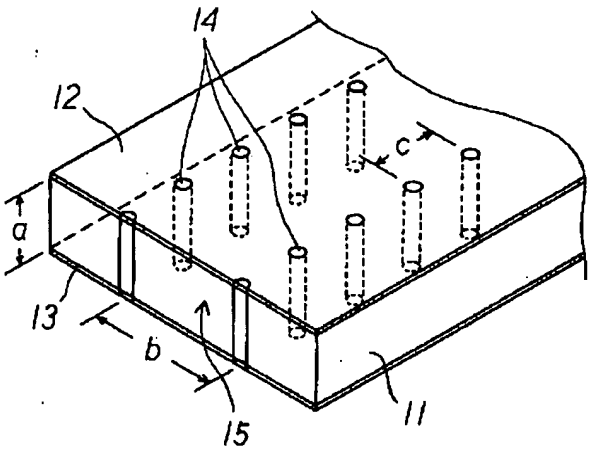

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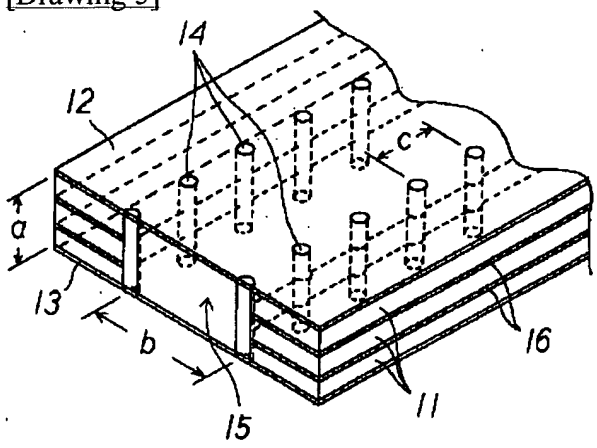

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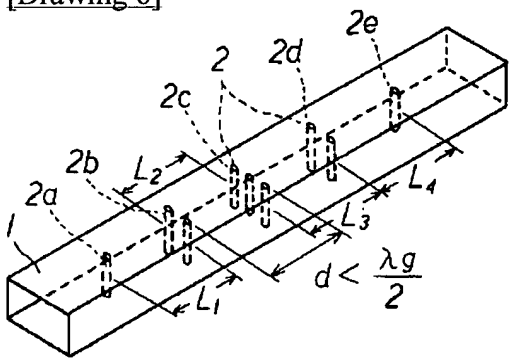

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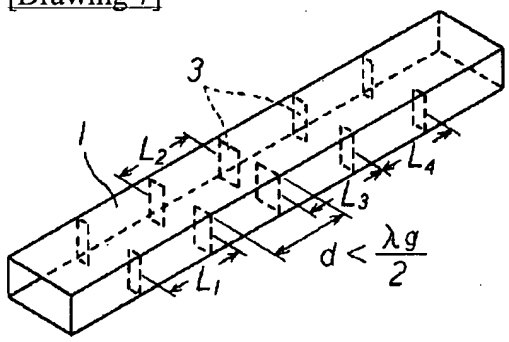

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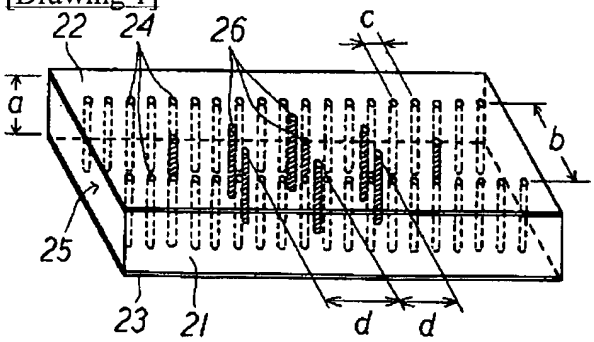
* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

[Drawing 1]



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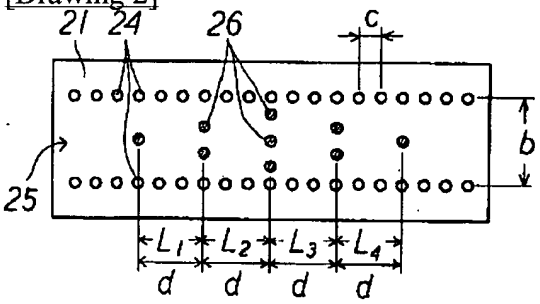

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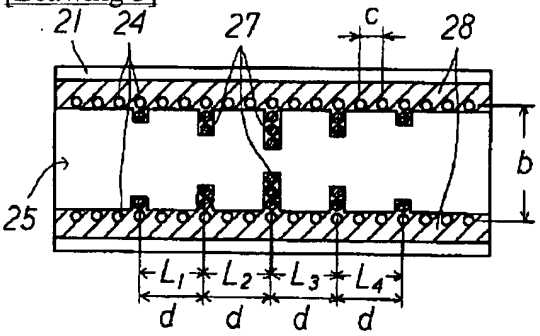

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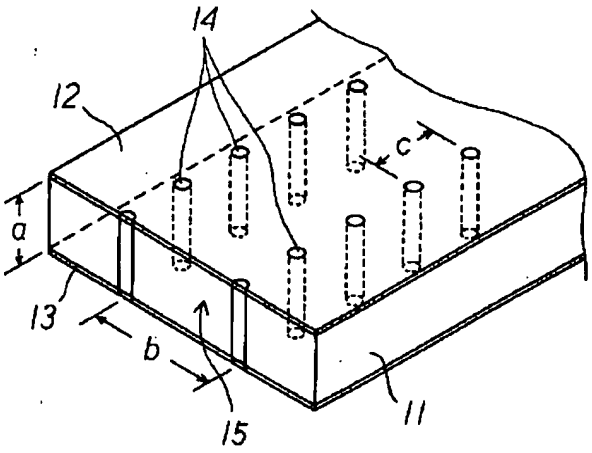

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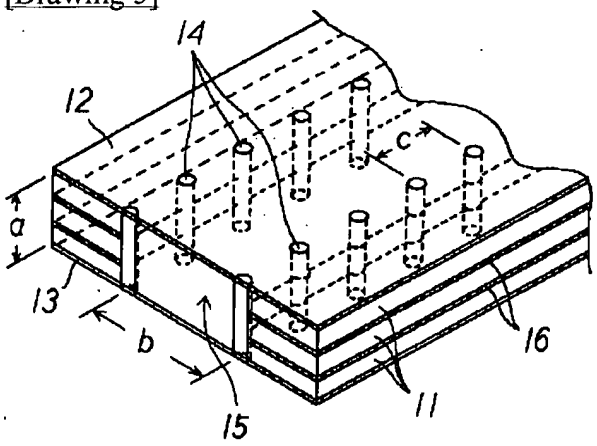

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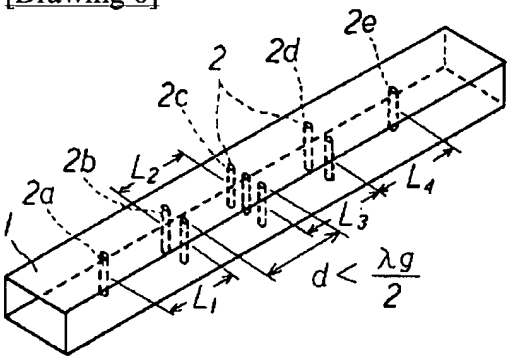

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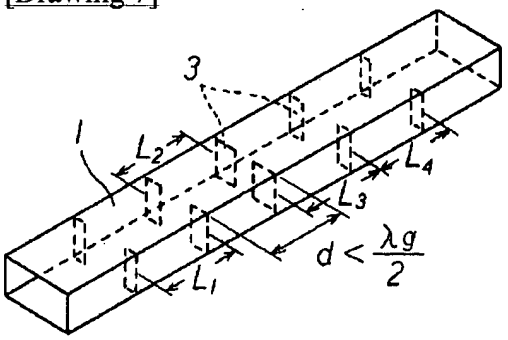

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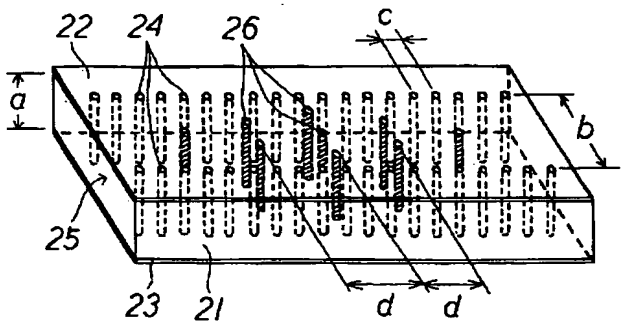
(54)【発明の名称】導波管型帯域通過フィルタ

(57)【要約】
【課題】　矩形導波管を用いた導波管型帯域通過フィルタでは、小型化が図れず、生産性も低かった。
【解決手段】　誘電体基板21を挟持する一対の主導体層22・23と、信号伝送方向に信号波長の２分の１未満の間隔で主導体層22・23間を電気的に接続して形成された２列の側壁用貫通導体群24とを具備して成り、主導体層22・23および側壁用貫通導体群24に囲まれた領域によって高周波信号を伝送する誘電体導波管線路25の内部に、主導体層22・23間を電気的に接続して誘導性窓を形成する複数の貫通導体26が信号伝送方向に管内波長の２分の１未満の間隔で配設されている導波管型帯域通過フィルタである。小型で生産性が高い、良好な特性の導波管型帯域通過フィルタとなる。



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【特許請求の範囲】

【請求項１】　誘電体基板を挟持する一対の主導体層と、信号伝送方向に信号波長の２分の１未満の間隔で前記主導体層間を電気的に接続して形成された２列の側壁用貫通導体群とを具備して成り、前記主導体層および側壁用貫通導体群に囲まれた領域によって高周波信号を伝送する誘電体導波管線路の内部に、前記主導体層間を電気的に接続して誘導性窓を形成する複数の貫通導体が前記信号伝送方向に管内波長の２分の１未満の間隔で配設されていることを特徴とする導波管型帯域通過フィルタ。

【請求項２】　前記主導体層間に、前記側壁用貫通導体群と電気的に接続された副導体層が前記主導体層と平行に形成されていることを特徴とする請求項１記載の導波管型帯域通過フィルタ。

【請求項３】　前記副導体層が、前記誘電体導波管線路の内部に延設されて前記貫通導体と電気的に接続され、該貫通導体と共に前記誘導性窓を形成していることを特徴とする請求項２記載の導波管型帯域通過フィルタ。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、主にマイクロ波およびミリ波等の高周波信号を伝送する誘電体導波管線路を用いた導波管型帯域通過フィルタに関するものである。

【０００２】

【従来の技術】近年、マイクロ波やミリ波などの高周波を用いた移動体通信および車間レーダ等の研究が盛んに進められている。これらの高周波を利用した技術には特定の周波数の高周波信号のみを通す帯域通過フィルタが必要である。

【０００３】高周波用の帯域通過フィルタには様々な構成のものがあるが、良好な帯域通過特性を有するものとして矩形導波管を用いた導波管型帯域通過フィルタが知られている。これには、例えば図６および図７に概略斜視図で示すような構造のものがある。

【０００４】図６に示した構造のものは、矩形導波管１の内部に誘導性窓を形成する複数の金属棒等のショートピン２（２ａ～２ｅ）を垂直に管内波長λｇの２分の１未満の間隔ｄ（ｄ＜λｇ／２）で信号伝送方向に配置することによって帯域通過フィルタを形成したものである。

【０００５】この構造によれば、導波管のほぼ中央部にあるショートピン２ｃあるいはショートピン群２ａ～２ｅにより、導波管の幅は遮断波長の２分の１以下に分断される。その結果、ショートピン２により導波管を伝播してきた電磁波は反射されるので、同図中に示した領域Ｌ１～Ｌ４は電気的に閉じた空間とみなすことができる。この閉じた空間は固有の共振モードを持ち、その長さｄがλｇ／２のとき最も低い周波数で共振を起こす共振器として機能する。図６に示した構造の場合、ショートピン２による壁で形成された４つの共振器が導波管に直列に結合しているものとみなすことができる。

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【０００６】前述したように、図６における左方の入力側から導波管１を伝播してきた電磁波はショートピン２ａにより伝播できなくなるが、その電磁波の周波数が前述した共振器の持つ固有の共振周波数と一致した場合にはショートピン２ａの間（誘導性窓）から電磁的な結合によって共振領域Ｌ１にエネルギーが流入する。同様にして、Ｌ１からＬ２へ、Ｌ２からＬ３へ、Ｌ３からＬ４へとエネルギーが伝播し、導波管１の図６における右方の出力側からはまた電磁波として伝播する。従って、固有の周波数を持つ電磁波のみがこれらの構造による領域を通過することができ、これにより帯域通過フィルタとして動作するものである。

【０００７】なお、前述した共振領域Ｌ１～Ｌ４は、結合のための誘導性窓があるため、それらの長さｄは一般にλｇ／２よりも短くなる。

【０００８】また、図７に示した構造のものは、矩形導波管１の内部に誘導性窓（誘導性壁）を形成する複数の金属板等のショート板３を同じく垂直に管内波長λｇの２分の１未満の間隔ｄ（ｄ＜λｇ／２）で信号伝送方向に配置することによって帯域通過フィルタを形成したものである。

【０００９】これによれば、ショート板３とそれによる誘導性窓が前述したショートピン２およびその隙間と全く同様に働くことにより帯域通過フィルタとなるものである。

【００１０】

【発明が解決しようとする課題】このような構造を持った従来の矩形導波管による帯域通過フィルタは、高周波信号に対する帯域通過特性は優れるものの、作製時の加工が難しいという問題点があった。このため、生産性が低くその結果コストが高くなるという問題点があった。

【００１１】また、矩形導波管そのもののサイズが大きいため、これを用いた帯域通過フィルタも大きなものとなり、移動体通信および車間レーダ等に利用するための小型化が困難であるという問題点もあった。

【００１２】本発明は上記事情に鑑みて案出されたものであり、その目的は、生産性が高く小型化にも対応できる導波管型帯域通過フィルタを提供することにある

【００１３】

【課題を解決するための手段】本発明者らは、上記の問題点に対して検討を重ねた結果、従来の矩形導波管に代えて、図４および図５にそれぞれ概略斜視図で示すような、一対の主導体層に挟持された誘電体基板中に信号伝送方向に信号波長の２分の１未満の間隔で主導体層間を電気的に接続して形成された２列の側壁用貫通導体群により導波管の側壁を形成した誘電体導波管線路（特開平６－53711 号ならびに特願平８－２２９９２５号参照）

を用い、その誘電体導波管線路の内部に誘導性窓を形成するショートピンに相当する複数の貫通導体を形成して信号伝送方向に管内波長の２分の１未満の間隔で配設することにより、誘電体導波管線路を用いて図６ならびに図７に示した構造と同様の導波管型帯域通過フィルタを製造できることを見出した。

【００１４】本発明の導波管型帯域通過フィルタは、誘電体基板を挟持する一対の主導体層と、信号伝送方向に信号波長の２分の１未満の間隔で前記主導体層間を電気的に接続して形成された２列の側壁用貫通導体群とを具備して成り、前記主導体層および側壁用貫通導体群に囲まれた領域によって高周波信号を伝送する誘電体導波管線路の内部に、前記主導体層間を電気的に接続して誘導性窓を形成する複数の貫通導体が前記信号伝送方向に管内波長の２分の１未満の間隔で配設されていることを特徴とするものである。

【００１５】また、本発明の導波管型帯域通過フィルタは、上記構成において、前記主導体層間に、前記側壁用貫通導体群と電気的に接続された副導体層が前記主導体層と平行に形成されていることを特徴とするものである。

【００１６】さらに、本発明の導波管型帯域通過フィルタは、副導体層が形成された上記構成の導波管型帯域通過フィルタにおいて、前記副導体層が、前記誘電体導波管線路の内部に延設されて前記貫通導体と電気的に接続され、該貫通導体と共に前記誘導性窓を形成していることを特徴とするものである。

【００１７】

【発明の実施の形態】以下、本発明の導波管型帯域通過フィルタについて図面を参照しながら説明する。

【００１８】図４および図５は、それぞれ本発明の導波管型帯域通過フィルタに用いる誘電体導波管線路の構成を示す概略斜視図である。これらの図において、１１は誘電体基板、12・13は誘電体基板11を挟持する一対の主導体層、14は信号伝送方向に信号波長の２分の１未満の間隔で主導体層12・13間を電気的に接続して形成された２列の側壁用貫通導体群である。

【００１９】図４および図５によれば、所定の厚みａの誘電体基板11を挟持する位置に一対の主導体層12・13が形成されており、主導体層12・13は誘電体基板11の少なくとも導波管線路形成位置を挟む上下面に形成されている。また、主導体層12・13間には主導体層12と13とを電気的に接続するスルーホール導体やビアホール導体等の貫通導体が多数設けられ、２列の側壁用貫通導体群14を形成している。

【００２０】２列の側壁用貫通導体群14は、所定間隔（幅）ｂをもって、信号伝送方向に信号波長の２分の１未満の所定間隔ｃをもって形成されており、これによりこの誘電体導波管線路における側壁を形成している。

【００２１】ここで、誘電体基板11の厚みａすなわち一対の主導体層12・13間の間隔に対する制限は特にないが、シングルモードで用いる場合には間隔ｂに対して２分の１程度または２倍程度とすることがよく、図４および図５の例では誘電体導波管のＨ面とＥ面に当たる部分がそれぞれ主導体層12・13と側壁用貫通導体群14で形成され、間隔ｂに対して厚みａを２倍程度とすれば、誘電体導波管のＥ面とＨ面に当たる部分がそれぞれ主導体層12・13と側壁用貫通導体群14で形成されることとなる。また、間隔ｃが信号波長（遮断波長）の２分の１未満の間隔に設定されることで側壁用貫通導体群14が電気的な壁を形成している。

【００２２】平行に配置された一対の主導体層12・13間にはＴＥＭ波が伝播できるため、側壁用貫通導体群14の間隔ｃが信号波長すなわち遮断波長λｃよりも大きいと、この導波管線路に電磁波を給電しても、ここで作られる疑似的な導波管に沿って伝播しない。しかし、側壁用貫通導体群14の間隔ｃが遮断波長λｃよりも小さいと、電磁波は導波管線路に対して垂直方向に伝播することができず、反射しながら導波管線路の信号伝送方向に伝播される。その結果、図４および図５の構成によれば、一対の主導体層12・13および２列の側壁用貫通導体群14によって囲まれる断面積がａ×ｂのサイズの領域が誘電体導波管線路15となる。

【００２３】なお、図５における16は側壁用貫通導体群14の各列を形成する貫通導体同士を電気的に接続する、主導体層12・13と平行に形成された副導体層であり、所望により適宜形成される。このような副導体層16を形成することにより、誘電体導波管線路15の内部から見ると線路の側壁は側壁用貫通導体群14と副導体層16とによって細かな格子状になり、線路からの電磁波の遮蔽効果をさらに高めることができる。

【００２４】また、これらの態様では側壁用貫通導体群14は２列に形成したが、この側壁用貫通導体群14を４列あるいは６列に配設して、側壁用貫通導体群14による疑似的な導体壁を２重・３重に形成することにより、導体壁からの電磁波の漏れをより効果的に防止することができる。

【００２５】上記の誘電体導波管線路によれば、誘電体導波管による伝送線路となるので、その導波管サイズは誘電体基板11の比誘電率をεとすると通常の導波管の１／$\sqrt{\varepsilon}$の大きさになる。従って、誘電体基板11を比誘電率εの大きい材料によって構成するほど、導波管サイズは小さくすることができ、高密度に配線が形成される多層配線基板または半導体素子収納用パッケージあるいは車間レーダの伝送線路として利用可能な大きさになる。

【００２６】なお、側壁用貫通導体群14を構成する貫通導体は前述のように遮断波長λｃの２分の１未満の間隔ｃで配設されており、この間隔ｃは良好な伝送特性を実現するためには一定の繰り返し間隔とすることが望ましいが、遮断波長λｃの２分の１未満の間隔であれば適宜

変化させたりいくつかの値を組み合わせたりしてもよいことは言うまでもない。

【００２７】このような誘電体導波管線路を構成する誘電体基板11としては、誘電体として機能し高周波信号の伝送を妨げることのない特性を有するものであればとりわけ限定するものではないが、伝送線路を形成する際の精度および製造の容易性の点からは、誘電体基板11はセラミックスからなることが望ましい。

【００２８】このようなセラミックスとしてはこれまで様々な比誘電率を持つセラミックスが知られているが、本発明の導波管線路によって高周波信号を伝送するためには常誘電体であることが望ましい。これは、一般に強誘電体セラミックスは高周波領域では誘電損失が大きく伝送損失が大きくなるためである。従って、誘電体基板11の比誘電率ϵ_rは４～100 程度が適当である。

【００２９】また、一般に多層配線基板や半導体素子収納用パッケージあるいは車間レーダに形成される配線層の線幅は最大でも１ｍｍ程度であることから、比誘電率が100 の材料を用い、上部がＨ面すなわち磁界が上側の面に平行に巻く電磁界分布になるように用いた場合、用いることのできる最小の周波数は15ＧＨｚと算出され、マイクロ波帯の領域でも利用可能となる。一方、一般的に誘電体基板11として用いられる樹脂からなる誘電体は、比誘電率ϵ_rが２程度であるため、線幅が１ｍｍの場合、約100 ＧＨｚ以上でないと利用することができないものとなる。

【００３０】また、このような常誘電体セラミックスの中にはアルミナやシリカ等のように誘電正接が非常に小さなものが多いが、全ての常誘電体セラミックスが利用可能であるわけではない。誘電体導波管線路の場合は導体による損失はほとんどなく、信号伝送時の損失のほとんどは誘電体による損失であり、誘電体による損失α（ｄＢ／ｍ）は下記のように表わされる。

$$\alpha = 27.3 \times \tan\delta / [\lambda / \{1 - (\lambda/\lambda c)^2\}^{1/2}]$$

式中、$\tan\delta$：誘電体の誘電正接

λ　　：誘電体中の波長

λc　　：遮断波長

規格化された矩形導波管（ＷＲＪシリーズ）形状に準ずると、上式中の$\{1 - (\lambda/\lambda c)^2\}^{1/2}$は0.75程度である。

【００３１】従って、実用に供し得る伝送損失である－100 ｄＢ／ｍ以下にするには、下記の関係が成立するように誘電体を選択することが必要である。

【００３２】$f \times \epsilon_r^{1/2} \times \tan\delta \leqq 0.8$

式中、ｆは使用する周波数（ＧＨｚ）である。

【００３３】このような誘電体基板11としては、例えばアルミナセラミックスやガラスセラミックス・窒化アルミニウムセラミックス等があり、例えばセラミックス原料粉末に適当な有機溶剤・溶媒を添加混合して泥漿状になすとともにこれを従来周知のドクターブレード法やカレンダーロール法等を採用してシート状となすことによって複数枚のセラミックグリーンシートを得、しかる後、これらセラミックグリーンシートの各々に適当な打ち抜き加工を施すとともにこれらを積層し、アルミナセラミックスの場合は1500～1700℃、ガラスセラミックスの場合は850 ～1000℃、窒化アルミニウムセラミックスの場合は1600～1900℃の温度で焼成することによって製作される。

【００３４】また、一対の主導体層12・13としては、例えば誘電体基板11がアルミナセラミックスから成る場合、タングステン等の金属粉末に適当なアルミナ・シリカ・マグネシア等の酸化物や有機溶剤・溶媒等を添加混合してペースト状にしたものを厚膜印刷法により少なくとも伝送線路を完全に覆うようにセラミックグリーンシート上に印刷し、しかる後、約1600℃の高温で焼成し、厚み10～15μｍ以上となるようにして形成する。なお、金属粉末としては、ガラスセラミックスの場合は銅・金・銀が、窒化アルミニウムセラミックスの場合はタングステン・モリブデンが好適である。また、主導体層12・13の厚みは一般的に５～50μｍ程度とされる。

【００３５】また、側壁用貫通導体群14を構成する貫通導体としては、例えばビアホール導体やスルーホール導体等により形成すればよく、その断面形状も製作が容易な円形の他、矩形や菱形等の多角形であってもよい。これら貫通導体は、例えばセラミックグリーンシートに打ち抜き加工を施して作製した貫通孔に主導体層12・13と同様の金属ペーストを埋め込み、しかる後、誘電体基板11と同時に焼成し形成する。なお、これらの貫通導体は直径50～300 μｍが適当である。

【００３６】次に、このような誘電体導波管線路を用いた本発明の導波管型帯域通過フィルタの実施の形態の一例を図１および図２に基づいて説明する。

【００３７】図１は本発明の導波管型帯域通過フィルタの実施の形態の一例を示す概略斜視図であり、図２は平面図である。これらの図において、21は厚みａの誘電体基板、22および23は誘電体基板21を挟持して形成された一対の主導体層、24は所定間隔（幅）ｂでもって信号伝送方向に信号波長（遮断波長λｃ）の２分の１未満の間隔ｃで主導体層22・23間を電気的に接続して形成された２列の側壁用貫通導体群、25は一対の主導体層22・23と２列の側壁用貫通導体群24とで囲まれた領域によって構成される誘電体導波管線路部である。

【００３８】これら誘電体基板21、主導体層22・23および側壁用貫通導体群24は、前述の本発明に用いる誘電体導波管線路と同様にして構成される。

【００３９】また、これらの図中に斜線を施して示した26は、誘電体導波管線路25の内部に信号伝送方向に管内波長λｇの２分の１未満の間隔ｄ（$d < \lambda g/2$）で配設された、主導体層22・23間を電気的に接続して誘導性

窓を形成する複数の貫通導体である。

【００４０】本発明によれば、このように誘電体導波管線路25の内部に誘導性窓を形成する複数の貫通導体26を管内波長λｇの２分の１未満の所定間隔ｄでもって配設してそれら貫通導体26の数を調整することにより、一対の主導体層22・23と２列の側壁用貫通導体群24とにより構成される誘電体導波管線路25が図６に示した矩形導波管１に相当し、複数の貫通導体26が図６に示したショートピン２に相当するものとなって、図６に示した矩形導波管を用いた導波管型帯域通過フィルタと全く同じ原理により同様の導波管型帯域通過フィルタを形成することができる。

【００４１】このような本発明の導波管型帯域通過フィルタによれば、従来の矩形導波管を用いた導波管型帯域通過フィルタに比べて、誘電体導波管となって小型に作製することができるため多層配線基板や半導体素子収納用パッケージを構成する誘電体基板内に作り込むことができ、小型化への対応が容易な導波管型帯域通過フィルタとなる。しかも、グリーンシート積層法等のシート積層技術により容易に作製することができるので、生産性が高く安価な製造が可能な導波管型帯域通過フィルタとなる。

【００４２】本発明の導波管型帯域通過フィルタにおいて誘導性窓を形成する複数の貫通導体26を配設する場合、ショートピンとして機能する貫通導体26のそれぞれの間隔や本数・大きさ等がフィルタ特性に複雑に関与する。このため、要求されるフィルタ特性を満足するように電磁界解析により繰り返し計算することにより、所望の帯域通過特性を有する導波管型帯域通過フィルタを得ることとなる。

【００４３】また、図１および図２に示した導波管型帯域通過フィルタは、図４に示した誘電体導波管線路に対して誘導性窓を形成する複数の貫通導体26を配設した構成となっているが、これにさらに図５に示した誘電体導波管線路のように、主導体層22・23間に主導体層22・23と平行に側壁用貫通導体群24と電気的に接続された副導体層を形成してもよい。そのように副導体層を形成した場合には、側壁用貫通導体群24により形成される疑似的な導体壁が電気的な壁としてより強化されるので、電磁波の伝送特性や遮蔽効果をさらに高めることができ、良好な帯域通過特性を有する導波管型帯域通過フィルタとなる。

【００４４】次に、図３に本発明の導波管型帯域通過フィルタの実施の形態の他の例を、図２と同様の平面図で示す。図３は図２と同じく本発明の導波管型帯域通過フィルタの内部構造を示す平面図であり、図３において図２と同様の箇所には同じ符号を付してある。

【００４５】図３は誘電体導波管線路として図５に示した副導体層16を有する本発明に係る誘電体導波管線路を用いて、図７に示した従来の導波管型帯域通過フィルタの構成を実現したものである。図３において27は誘電体導波管線路25の内部に信号伝送方向に管内波長λｃの２分の１未満の間隔ｄで配設された、主導体層22・23間を電気的に接続して誘導性窓を形成する複数の貫通導体であり、これら複数の貫通導体27は、図７に示したショート板３と同様の誘導性窓を形成するようにして導波管内に配設されている。

【００４６】また、28は副導体層であり、この例における副導体層28は、２列の側壁用貫通導体群24とそれぞれの列において電気的に接続されているとともに、一対の主導体層22・23と２列の側壁用貫通導体群24とで囲まれた領域によって形成される誘電体導波管線路25の内部に延設されて誘導性窓を形成する複数の貫通導体27とそれぞれの側壁用貫通導体群24側において電気的に接続され、この延設された部分により貫通導体27と共に誘導性窓を形成している。

【００４７】このように、複数の貫通導体27と、誘電体導波管線路25の内部に延設されてそれら貫通導体27と電気的に接続された副導体層28とにより形成した誘導性窓を管内波長λｇの２分の１未満の所定の間隔ｄで配設することにより、一対の主導体層22・23と２列の側壁用貫通導体群24とにより構成される誘電体導波管線路25が図７に示した矩形導波管１に相当し、複数の貫通導体27と副導体層28とにより形成される誘導性窓が図７に示したショート板３に相当するものとなって、図６および図７に示した導波管型帯域通過フィルタと全く同様の原理により、図７に示した矩形導波管を用いた導波管型帯域通過フィルタと同様の導波管型帯域通過フィルタを形成することができる。

【００４８】このような本発明の導波管型帯域通過フィルタによっても、小型化への対応が容易で生産性が高く安価な製造が可能な導波管型帯域通過フィルタとなる。

【００４９】この例のように誘導性窓を形成する複数の貫通導体27および副導体層28を配設する場合、前述した貫通導体26の場合と同様に、要求されるフィルタ仕様を満足するように解析シミュレータを用いて、所望の帯域通過特性を有する導波管型帯域通過フィルタを得ることとなる。

【００５０】なお、複数の貫通導体26・27は、側壁用貫通導体群24の貫通導体と同様に前述のようにして形成すればよい。また、その断面形状は円形に限られず、所望の帯域通過特性に応じて楕円形や三角形・四角形・多角形、あるいは平板状としてもよいものである。

【００５１】なお、本発明は以上の実施の形態の例に限定されるものではなく、本発明の要旨を逸脱しない範囲で種々の変更や改良を施すことは何ら差し支えない。例えば、以上の例では共振部が４段（L_1～L_4）のフィルタとしたが、フィルタの仕様に応じて多段のフィルタとしてもよい。

【００５２】

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【発明の効果】以上詳述した通り、本発明の導波管型帯域通過フィルタによれば、誘電体導波管線路の内部に、誘電体基板を挟持する一対の主導体層間を電気的に接続して誘導性窓を形成する複数の貫通導体を信号伝送方向に管内波長λｇの２分の１未満の間隔で配設したことから、誘電体導波管となって従来の矩形導波管を用いた導波管型帯域通過フィルタに比べて小型に作製することができるため多層配線基板等の誘電体基板内に作り込むことができ、小型化への対応が容易な導波管型帯域通過フィルタとなり、しかも、グリーンシート積層法等のシート積層技術により容易に作製することができるので、生産性が高く安価な製造が可能な導波管型帯域通過フィルタとなる。

【００５３】また、本発明の導波管型帯域通過フィルタによれば、主導体層間に側壁用貫通導体群と電気的に接続された副導体層を主導体層と平行に形成した場合には、側壁用貫通導体群により形成される疑似的な導体壁が電気的な壁としてより強化されるので、電磁波の伝送特性や遮蔽効果をさらに高めることができ、良好な帯域通過特性を有する導波管型帯域通過フィルタとなる。

【００５４】さらに、本発明の導波管型帯域通過フィルタによれば、副導体層を誘電体導波管線路の内部に延設して誘導性窓を形成する貫通導体と電気的に接続し、貫通導体と共に誘導性窓を形成するようにした場合には、誘導性窓を形成する導体の部分が多くなるため、導体への電流の集中が緩和され、導体によるエネルギーの損失が小さくなることから、より優れた特性を有するものとなる。

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【００５５】以上により、本発明によれば、誘電体導波管線路を用いた導波管型帯域通過フィルタとして、生産性が高く小型化にも対応できる導波管型帯域通過フィルタを提供することができた。

【図面の簡単な説明】

【図１】本発明の導波管型帯域通過フィルタの実施の形態の一例を示す斜視図である。

【図２】本発明の導波管型帯域通過フィルタの実施の形態の一例を示す平面図である。

【図３】本発明の導波管型帯域通過フィルタの実施の形態の他の例を示す平面図である。

【図４】本発明の導波管型帯域通過フィルタに係る誘電体導波管線路を説明するための斜視図である。

【図５】本発明の導波管型帯域通過フィルタに係る誘電体導波管線路を説明するための斜視図である。

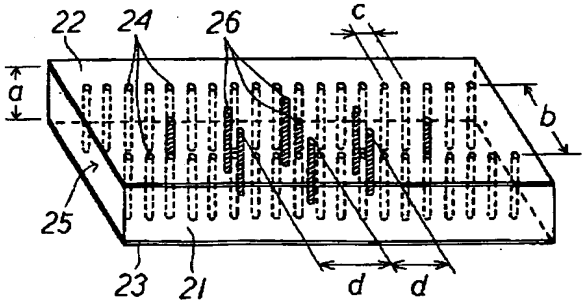
【図６】従来の導波管型帯域通過フィルタの例を示す斜視図である。

【図７】従来の導波管型帯域通過フィルタの他の例を示す斜視図である。

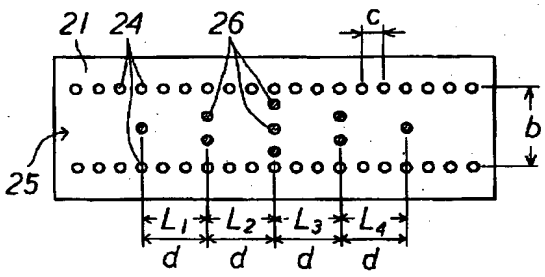
【符号の説明】

11、21・・・・・・・・誘電体基板
12、13、22、23・・・・主導体層
14、24・・・・・・・・側壁用貫通導体群
15、25・・・・・・・・誘電体導波管線路
26、27・・・・・・・・貫通導体
16、28・・・・・・・・副導体層

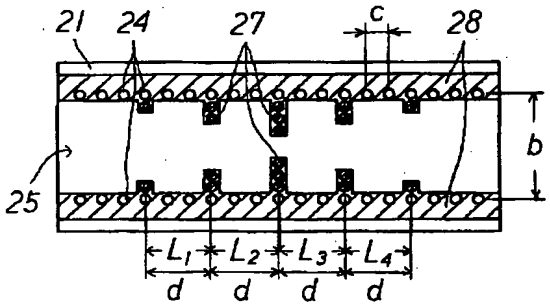
【図１】



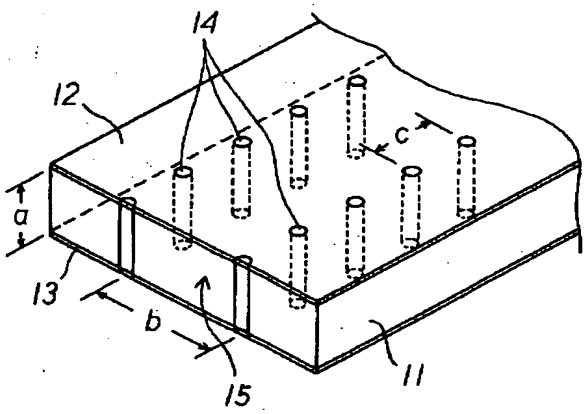
【図２】



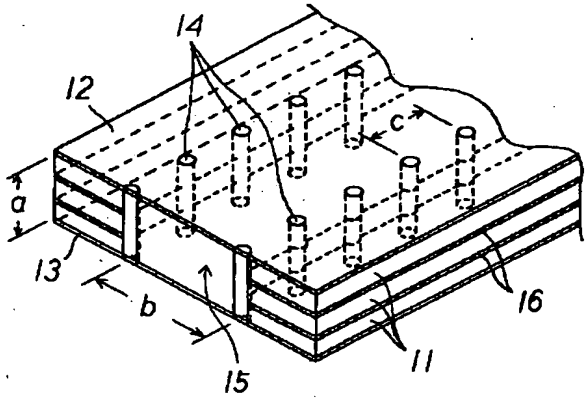
【図３】



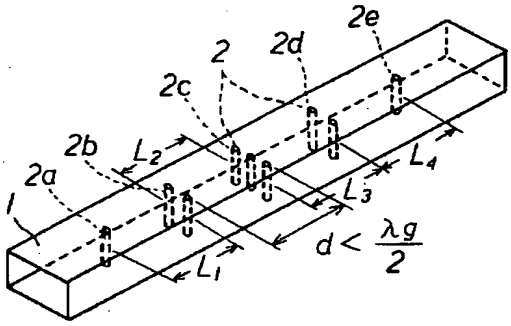
【図４】


14
12
c
a
13
b
15
11

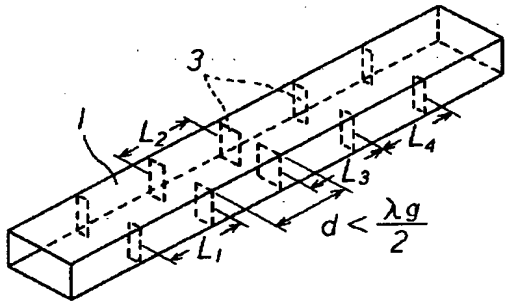
【図５】


14
12
c
a
13
b
15
16
11

【図６】


2e
2
2d
2c
2b
2a
1
L_2
L_4
L_3
L_1
$d < \frac{\lambda g}{2}$

【図７】


3
1
L_2
L_4
L_3
L_1
$d < \frac{\lambda g}{2}$